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(71) Applicant(s)
Hydril Company

(Incorporated in USA - Delaware)

714 West Olympic Boulevard, Los Angeles, California 90015, United States of America

(72) Inventor(s)
Douglas W. Carlson
Stephen P. Simons

(74) Agent and/or Address for Service
Langner Parry
High Holborn House, 52-54 High Holborn, LONDON, WC1V 6RR, United Kingdom

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GB 2166177 A GB 2017782 A GB 0640788 A

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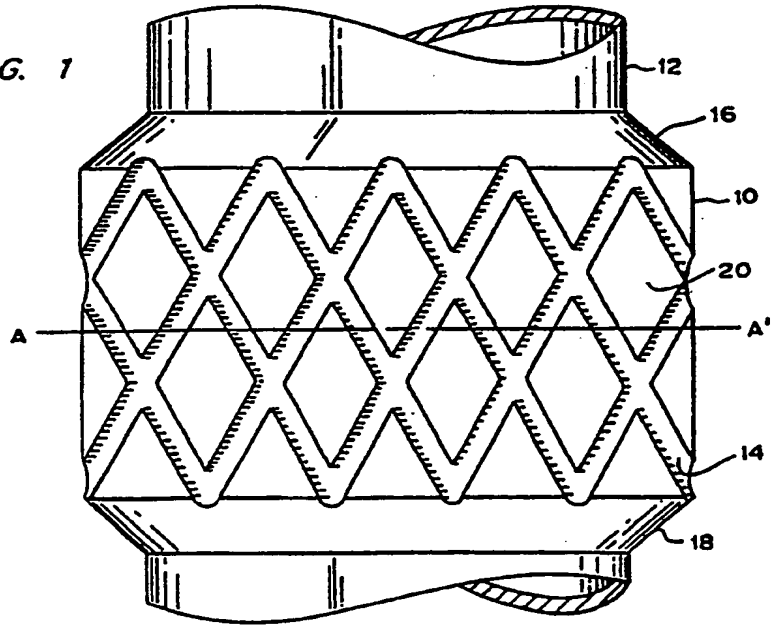
(54) Free flow low energy drill pipe protector

(57) A drill pipe protector 10 has been designed to provide free flow, low energy and to minimise vibrations. The protector 10 has an external pattern of raised figures such as diamonds 20, ovals or other geometric shapes surrounded by communicating channels 14. The pattern is bilaterally asymmetrical when comparing the approximate top half of the pipe protector to the bottom half of the pipe protector.

FIG. 1



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

FIG. 1

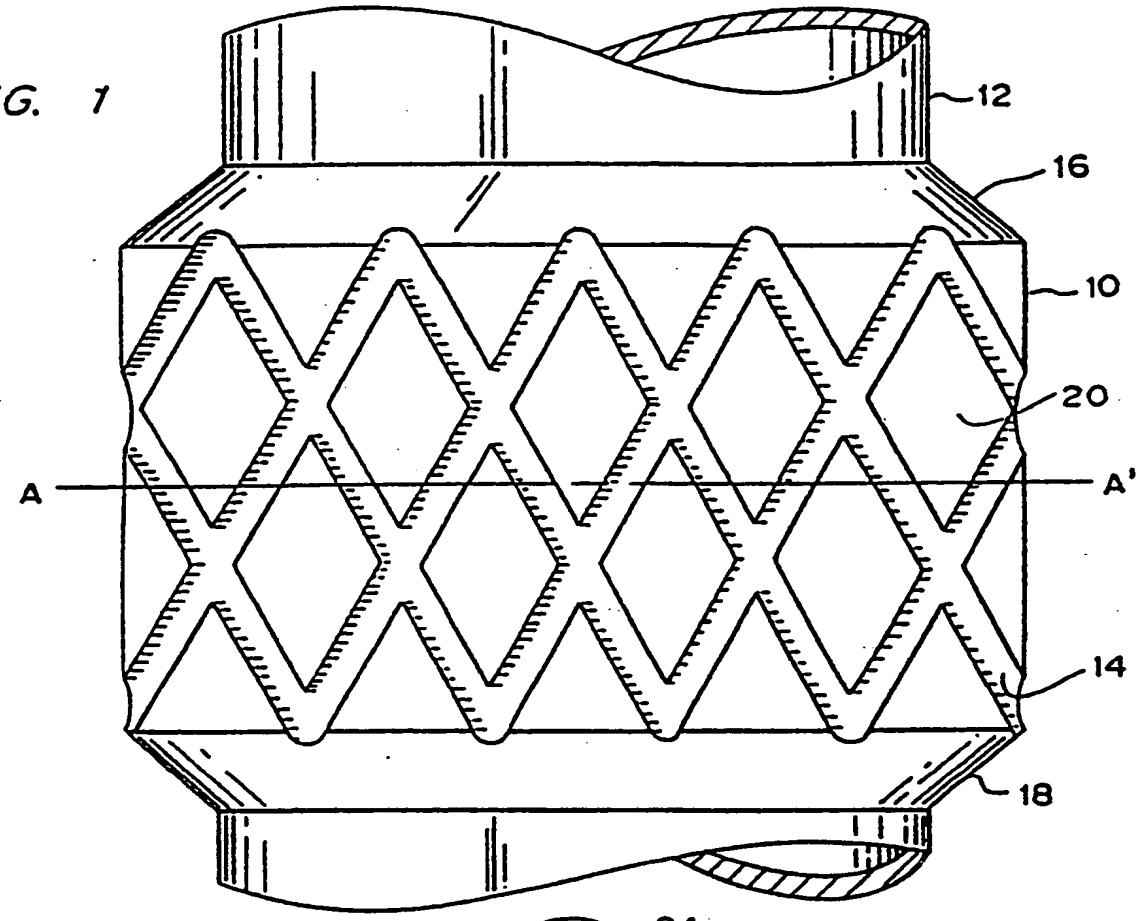


FIG. 2

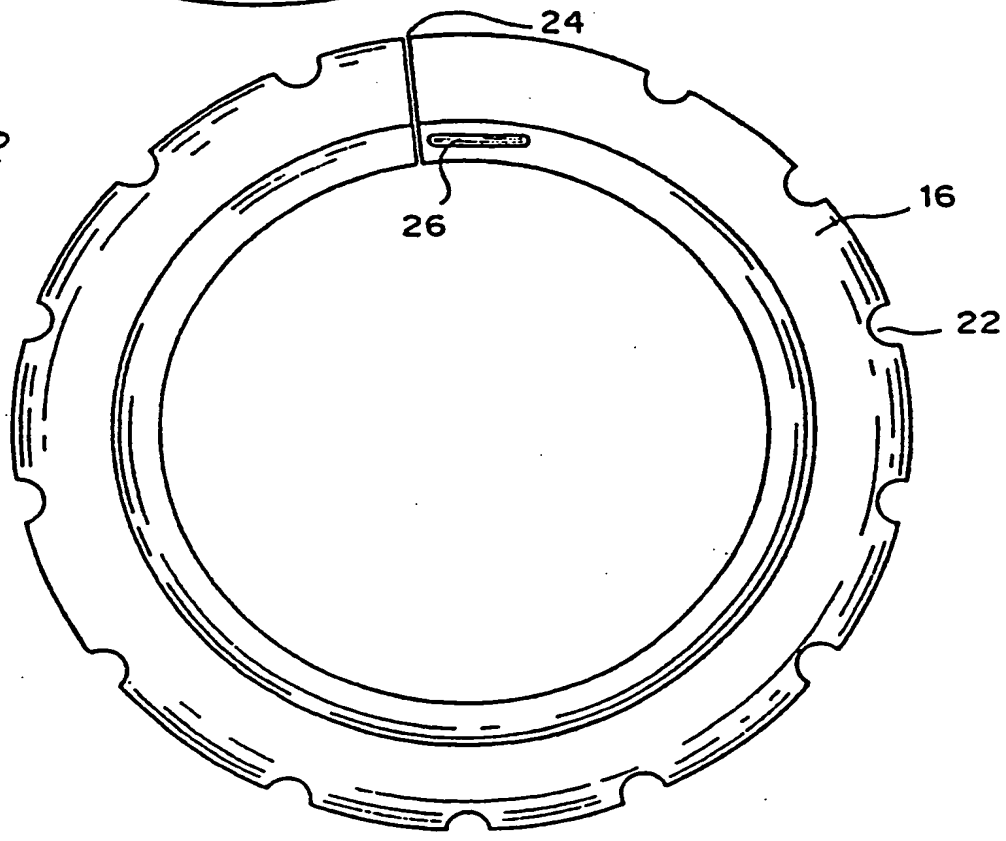


FIG. 3

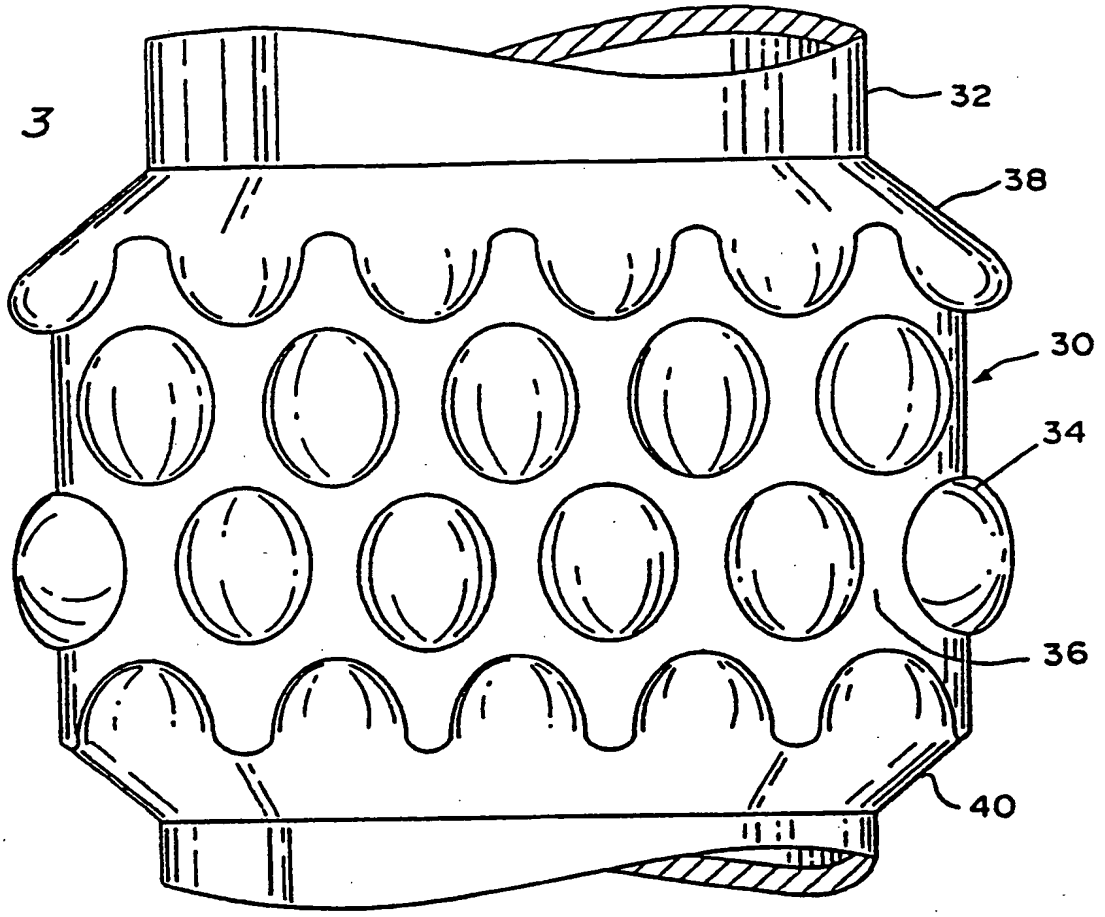
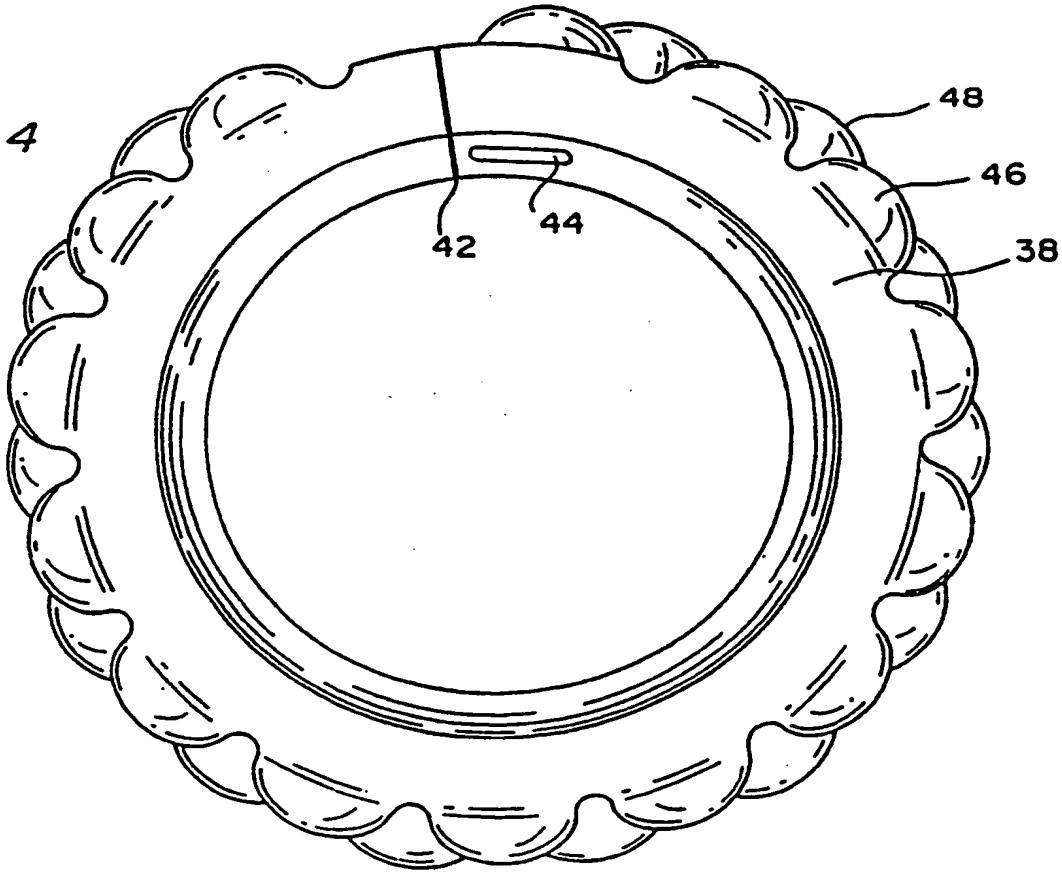


FIG. 4



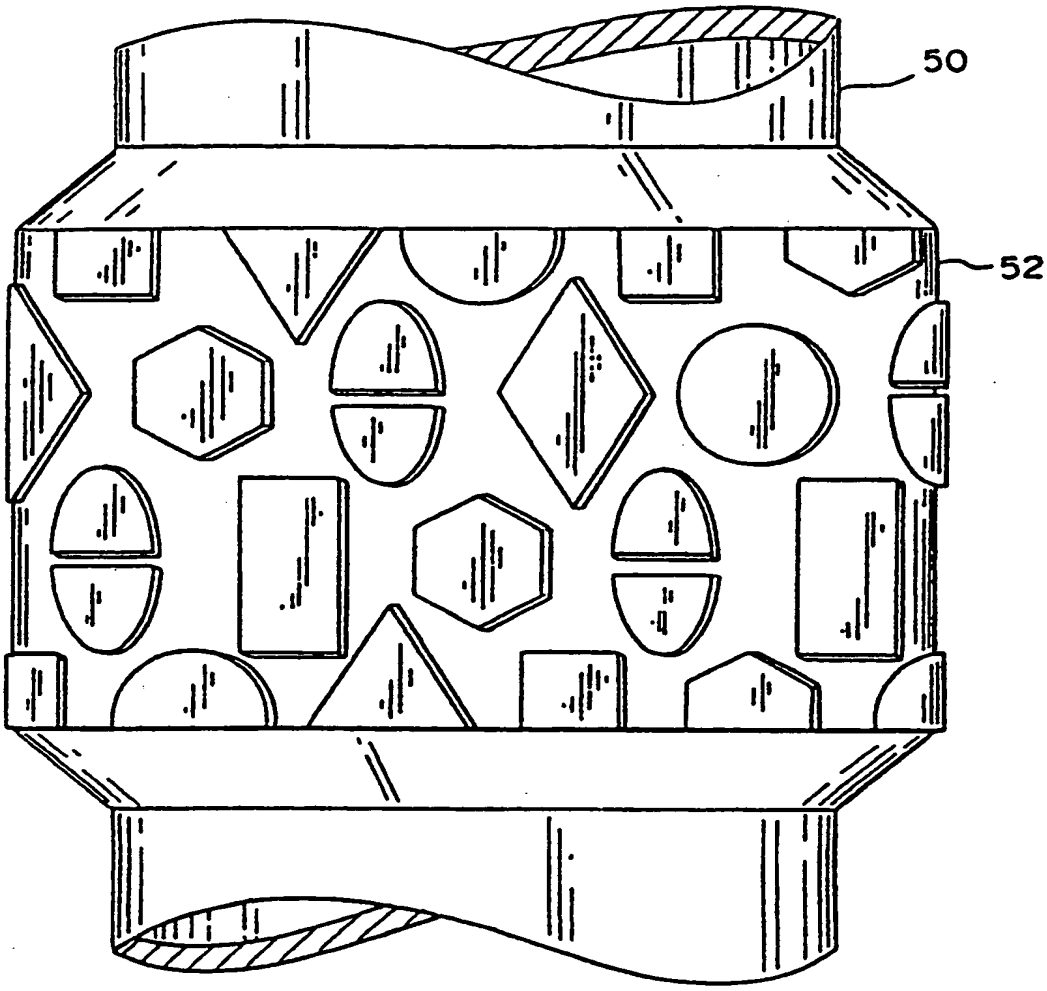


FIG. 5

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FREE FLOW LOW ENERGY PIPE PROTECTOR

Pipe protectors are tubular rubber members that surround pipe in downhole drilling operations. The rubber pipe protector contacts metal casing into which the pipe is introduced during the drilling operation. During drilling well completion fluids and drilling mud may be circulated in the annular space between the casing and the outside surface of the drill pipe. This annular space in the well also contains the pipe protector.

Pipe protectors with a slick or smooth outer surface provide maximum wear surface contacting the well casing. During the drilling operation the pipe is rapidly rotated. Directional or deviated drilling is at an angle in a non-vertical direction. The smooth surface pipe protectors are suited to high wear applications in directional drilling, but smooth pipe protectors restrict flow in tight holes.

Pipe protectors with fluted channels cut out of the outside surface provide fluid flow in tight holes. However, during rotation of the drill pipe the fluted configuration develop large vibration in tight holes especially during deviated drilling. Pipe protectors with the flutes cut in a spiral have been used. The spiral cut also produces large vibrations in deviated drilling.

The improved drill pipe protector of this invention combines the benefits of sufficient surface area for good wear characteristics and channels for fluid flow with low rotational energy requirements and vibration suppression. The tubular rubber member is sized to a pre-selected inner diameter to the approximate outside diameter of a pipe. A pattern on the outside surface of the rubber tubular member is made of raised surfaces surrounded by communicating channels. The pattern is bilaterally asymmetrical when comparing the pattern on the approximate top half of the pipe protector to the pattern on the approximate bottom half of the pipe protector.

In one embodiment the pattern uses the same geometric figure such as a diamond. The diamonds are not of the same size and configuration to provide the bilateral asymmetry at the midline of the pipe protector. A combination of geometric and irregular figures can also be used to create the midline asymmetry. In order to provide for fluid flow the channels preferably comprise from about 40% to about 70% of the pattern. The raised patterned surface also preferably is from 30% to 60% of the outside surface area to minimize wear during operation. Further, the raised surfaces may have a rounded outer contour.

The improved pipe protector can be adapted for use on pipe protectors known to those in the industry. A preferred design is a conventional split type pipe protector which has an opening the length of the tubular rubber member capable of separation at the opening to facilitate the installation on to a pipe. A closing means is provided to secure the tubular member around a pipe. Many split type pipe protectors have interlocking metal teeth covered by rubber and locked together with a key fastener inserted lengthwise through the teeth. The metal teeth are connected to a cylindrical metal insert inside the tubular rubber member. The metal insert may be smooth or corrugated metal. The split type pipe protector of the present invention has a pattern on the outside as described herein. Although the preferred embodiment of this invention is for a split type protector, the asymmetric pattern can also be used with a stretch-on type protector which is installed on the pipe by temporarily stretching or enlarging the inside diameter of the pipe protector to such a degree that the protector can be slipped over the end of the pipe. Further embodiments of the invention will be apparent from the following

description taken together with the accompanying drawings wherein:

Figure 1 is a side view of a pipe protector with a diamond and channel pattern with midline asymmetry installed on to a pipe;

Figure 2 is a top view of the diamond and channel pipe protector of Figure 1 not installed on to a pipe;

Figure 3 is a side view of a pipe protector with raised oval design and midline asymmetry installed on to a pipe;

Figure 4 is a top view of the raised oval pipe protector of Figure 3 not installed on to a pipe; and

Figure 5 is a side view of a pipe protector with a variety of figures installed on to a pipe.

The pipe protectors of this invention can be made from polymers generally used for downhole drilling, and known to those skilled in the art. A preferred rubber is high acrylonitrile butadiene copolymer also know as nitrile base polymer. The range of durometer hardness for the tubular member is from about 50 Shore A to about 80 Shore A. The preferred range is from about 65 - 70 Shore A durometer hardness.

The acrylonitrile copolymer rubber has oil and fuel resistance, high tensile and tear strength, abrasion and gas impermeability resistance and heat resistance. The acrylonitrile copolymer rubber can be compounded with other

additives known to those skilled in the art to improve and enhance certain characteristics.

A preferred polymer formula for a colored noncarbon reinforced rubber is shown in Table 1 below.

TABLE 1

Colored Non Carbon Reinforced Polymer

Component	Parts Per Hundred Polymer
NBR Polymer	100
Zinc Oxide	4 - 9
Silica	25 - 60
Stearic Acid	1.0 - 1.5
Antioxidants and Antiozonants	3.5 - 10.0
Processing Oils	25 - 50
Reinforcing Resin and Resin Curative	5 - 15
Iron Oxide Colorant	3 - 8
Sulfenamide Curative	2 - 5.5
Thiuram Curative	1.5 - 4.5

A preferred polymer formula for a carbon black reinforced polymer stock is shown in Table 2 below.

TABLE 2

Black Carbon Reinforced Polymer

Component	Parts Per Hundred Polymer
NBR Polymer	100
Zinc Oxide	4 - 9
Stearic Acid	1.0 - 1.5
Carbon Black (N774)	30 - 70
Antioxidant and Antiozonants	3.5 - 10.0
Processing Oils	25 - 50
Reinforcing Resin and Resin Curative	5 - 15
Sulfenamide Curative	2 - 5.5
Thiuram Curative	1.5 - 4.5

The pattern on the pipe protector is created by channels in the rubber on the outer surface. The channels surround a geometrical or irregular figure that is raised relative to the channel. The channel may be formed in any manner so long as fluid may flow there through. The channel may be a smooth semicircular U-shaped cut, a V-shaped cut or square cut. This list is not intended to exclude any channel form that allows for fluid flow. The channels on one pipe protector can be a combination of a variety of cuts. The channels extend to the shoulder of a split type pipe protector to allow for fluid flow past the pipe protector. The shoulders slope toward the inner diameter of the tubular member. The channels can be from about 40% to about 70% of the outside surface area on the pipe protector.

The pattern created by the channels has midline or bilateral asymmetry so that the pattern on the approximate top half of the pipe protector is asymmetrical when com-

pared to the approximate bottom half. The same geometric or irregular shape may be used or a mixture of shape. Geometric shapes that can be formed by the channels are diamonds, ellipses, circles, ovals, rectangles, hemispheres, parallelograms, trapezoids, triangles, multi-sided figures and irregular sided figures. This list is not intended to exclude any shape or form but is intended to be illustrative of the numerous figures that can be used. The surface of the raised figures may be flat or rounded.

Figure 1 illustrates a preferred embodiment of the pipe protector of the present invention. The tubular rubber member 10 is shown installed on to pipe 12. Channels, one of which is illustrated at reference numeral 14, are cut or molded on the outside surface of tubular member 10. The channels extend to shoulders 16 and 18 on either end of tubular member 10 to allow fluid flow. The channels create raised surfaces, and in Figure 1, are shown as diamonds one of which is illustrated at reference numeral 20. Line A-A' is the approximate midline of tubular member 10 and is drawn to illustrate the bilateral asymmetry when comparing the approximate top half to the approximate bottom half of the pipe protector.

Figure 2 is a top view of the pipe protector of Figure 1 not installed on to a pipe. The channels that extend to shoulder 16 are shown as U-shaped or semicircular cuts. One of such channels is shown at reference numeral 22. The top view shows a typical split type pipe protector as described herein with opening 24 and key 26 used to close the protector around the pipe.

Figure 3 is a side view of an alternative embodiment that illustrates the use of a rounded contour on the raised surfaces with an asymmetric oval pattern. The pipe protector generally indicated at reference numeral 30 is installed on to pipe 32. A series of raised ovals, one of

which is indicated at reference numeral 34, are arranged to provide bilateral asymmetry with the approximate top half and the bottom half of the pipe protector. Channels are provided around the raised, rounded oval pattern as indicated at reference numeral 36 for fluid flow as previously described herein. The channels extend to shoulders 38 and 40.

Figure 4 is a top view of the pipe protector shown in Figure 3 that is not installed on to a pipe. The top view shows the typical split type pipe protector with opening 42 and key 44 used to close the protector around the pipe. The series of offset raised, rounded ovals are shown with the top row as illustrated at reference numeral 46 truncated and blended into the shoulder 38. A row of offset ovals illustrated at reference numeral 48 can be seen in this view.

Figure 5 is the side view of another embodiment of the pipe protector of the present invention with multiple designs as it is installed on pipe 50. The tubular member 52 has a variety of shapes such as hexagons, semi-circles, circles, diamonds, rectangles and truncated shapes making up a bilateral asymmetrical pattern on the outside surface. The figures are raised and channels can be the irregular spaces between the figures.

The pipe protector of the present invention demonstrates low vibratory energy under drilling conditions. The diamond pattern pipe protector of a design similar to that shown in Figures 1 and 2 was tested and compared to slick and fluted pipe protectors. The pipe protectors were tested at actual loads encountered in the field. The height of the pipe protectors is 4 inches from shoulder to shoulder with an overall height of 6 inches. The pipe protectors were tested at 3000 and 6000 lbs/foot lateral load and 158 rpm. The vibratory energy measurement was

derived by measuring the amplitude of the fundamental wave and adding to it the amplitude of the first, second, third and fourth harmonic. This sum is converted to energy units which are proportional to the amplitude measurement. The resulting number for vibratory energy is used for comparative purposes among the pipe protectors tested.

The following Table 3 is a summary tests on vibratory energy for an asymmetrical diamond pattern, smooth and fluted pipe protector.

TABLE 3

Vibratory Energy

	Pipe Protector Pattern		
Load (lbs/ft.)	Diamond	Smooth	Fluted
3000	77.35	99.53	241.83
6000	67.22	100.34	265.45

In a comparison of the asymmetrical diamond pattern to the conventional smooth and fluted pipe protectors, the value for the asymmetrical diamond pattern was assigned the value 1 with the other numbers adjusted proportionally. The following Table 4 illustrates the reduced vibratory energy of the pipe protector of the present invention.

TABLE 4

Vibratory Energy Ratio

	Pipe Protector Pattern		
Load (lbs/ft.)	Diamond	Smooth	Fluted
3000	1	1.28	3.12
6000	1	1.49	3.94

The examples provided in this specification are not intended to limit the scope of the claimed invention.

Those skilled in the art will appreciate additional embodiments and variations that can be practiced based in addition to those disclosed herein.

CLAIMS

1. A pipe protector including a tubular rubber member sized to a preselected inner diameter to the approximate outside diameter of a pipe, a pattern on the outside surface of the tubular rubber member of raised surfaces surrounded by communicating channels, and said pattern is bilaterally asymmetrical when comparing the pattern on the approximate top half of the pipe protector to the pattern of the approximate bottom half.

2. The pipe protector of claim 1 wherein said communicating channels comprise from about 40% to about 70% of the pattern on the outside surface of the pipe protector.

3. The pipe protector of claim 1 or 2 wherein the pattern is a geometric design or a combination of different geometric figures.

4. The pipe protector of claim 1 or 2 wherein the pattern is a combination of geometric figures and irregular figures.

5. The pipe protector of any of claims 1 to 4 wherein said raised surfaces have sufficient surface area to minimize wear during operation.

6. The pipe protector of any of claims 1 to 5 wherein the raised surfaces have a rounded outer contour.

7. The pipe protector of any of claims 1 to 6 wherein said raised surfaces comprise from about 30% to about 60% of the pattern on the outside surface of the tubular member.

8. The pipe protector of any of the preceding claims wherein the tubular member is a stretch-on type protector.

9. The pipe protector of any of the preceding claims including sloped shoulders on either end of said

tubular member sloping toward the inner diameter of the tubular member and said channels extending to the shoulders.

10. The pipe protector of any of the preceding claims having an opening the length of the tubular member capable of separation at the opening to facilitate installation on to a pipe and a closing means to secure the tubular rubber member around the pipe.

11. A pipe protector including a tubular rubber member sized to a preselected inner diameter to the approximate outside diameter of a pipe, an opening the length of the tubular rubber member capable of separation at the opening to facilitate installation into a pipe, a closing means to secure the tubular member around a pipe, a pattern on the outside surface of the tubular member of irregular raised diamond figures with the raised surfaces surrounded by communicating channels, and said pattern bilaterally asymmetrical when comparing the pattern on the approximate top half of the pipe protector to the pattern on the approximate bottom half.

12. The pipe protector of claim 11 wherein said communicating channels comprise from about 40% to about 70% of the pattern.

13. The pipe protector of claims 11 or 12 wherein said raised diamond figures have sufficient surface area to minimize wear during operation.

14. The pipe protector of any of claims 11 to 13 wherein the diamond figures have a rounded outer contour.

15. The pipe protector of any of claims 11 to 14 wherein the diamond figures comprise from abut 30% to about 60% of the pattern on the outside surface of the tubular member.

16. The pipe protector of claim 12 additionally comprising sloped shoulders on either end of said tubular member sloping toward the inner diameter of the tubular

member and said channels extending to the shoulders.

17. A pipe protector constructed substantially as herein described with reference to the embodiments shown in Figures 1 and 2, Figures 3 and 4 or Figure 5 of the accompanying drawings.

The Patent Office

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Application No: GB 9507307.8 **Examiner:** D.J.Harrison
Claims searched: 1-17 **Date of search:** 2 June 1995

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.N): E1F FAC

Int Cl (Ed.6): E21B

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2166177 A	(Metal-X Corporation)	1,11
A	GB 2017782 A	(H Nieymeyer GmbH)	1
A	GB 640788	(United States Rubber Company)	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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